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AI & CIFAR - options

The issues & considerations :

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21(1)(a), 21(1)(b)

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(\$k)	Year					Total for years	
	Yr 1	Yr 2	Yr 3	Yr 5	Yr 10	Yrs 1-5	Yrs 1-10

AI Institute Budget per Academic Year

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
(\$k)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10

NOTES on the Budget

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20(1)(b), 21(1)(b)

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07 2017

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Action Required:
For meeting

ADVICE TO THE MINISTER OF SCIENCE

Meeting with Ed Clark Regarding Establishing an Ontario Artificial Intelligence Institute

SUMMARY

- You are meeting with Ed Clark, former President and CEO of TD Bank Group and current business advisor to the Premier of Ontario.
- The Ontario Government, the University of Toronto (UofT) and other stakeholders in the province are proposing to create an Ontario Artificial Intelligence Institute (OAI) in Toronto. [REDACTED]
- Canada is a global pioneer in the area of artificial intelligence (AI) research and development, with three main hubs of focused activity, anchored by research-intensive universities: Montréal, Toronto and Edmonton.
- [REDACTED] In addition, discussions are underway between ISED, the Canadian Institute for Advanced Research (CIFAR) and universities from Toronto, Montréal and Edmonton regarding the possibility of a pan-Canadian approach to collaboration in AI.

BACKGROUND

You are meeting with Ed Clark, former President and CEO of TD Bank Group and current business advisor to the Premier of Ontario. Mr. Clark is part of a consortium led by the Ontario Government, the UofT and other stakeholders in the province that proposes to create an OAI. Its purpose would be to drive the economy by leveraging and growing world class AI research in Ontario, and accelerating the resulting

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commercialization opportunities. The consortium is [REDACTED]

[REDACTED] A biography of Mr. Clark is attached as Annex B.

AI is the theory and development of computer systems that are able to perform tasks that normally require human intelligence. During the past five years, machine-learning algorithms have created breakthrough performance in many traditionally challenging areas of AI, such as image recognition and natural language understanding. Thanks to talent at Canadian universities, and the foresight of funding agencies such as CIFAR, Canada is an AI leader, particularly in promising subfields such as deep learning and reinforcement learning. Top nodes of expertise in Canada include Toronto, Montréal and Edmonton. In July 2016, the Université de Montréal was awarded \$93.6 million under the Canada First Excellence Research Fund (CFREF) in the area of AI. More information about AI and the Canadian poles of expertise is provided in Annex C.

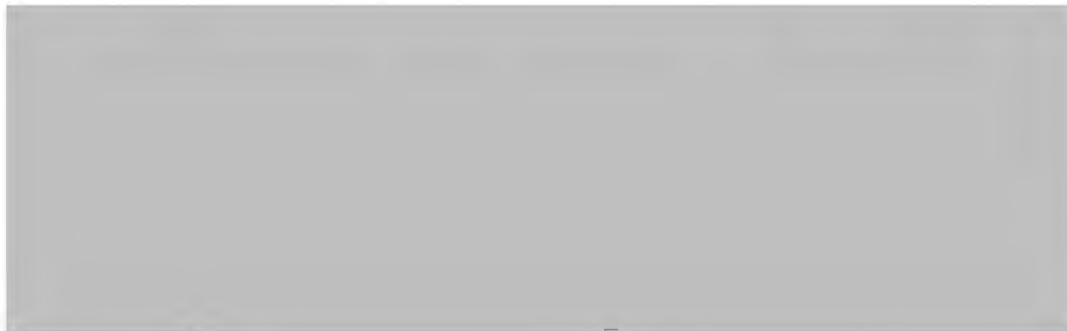
Canada faces challenges on AI talent development and retention. To meet the lower end of industry demand for AI PhDs, Canada would need to roughly double its current cohorts of AI students and increase its retention rate significantly. Over the past few years, several leading Canadian researchers and professors have defected to U.S. tech companies such as Google and to top U.S. universities. Many have suggested that Canada may be facing a "brain-drain" challenge in AI.

Canada also faces the challenge of leveraging its leadership and current momentum in AI to drive growth and foster innovation in the Canadian economy. The current approach to AI research and commercialization, divided by region, may not fully allow Canada to reap the full benefits of its talent. A combined approach would increase interaction between AI scientists and corporations; help to attract and retain top talent; train more students; and better leverage provincial and federal investments to be more competitive globally.

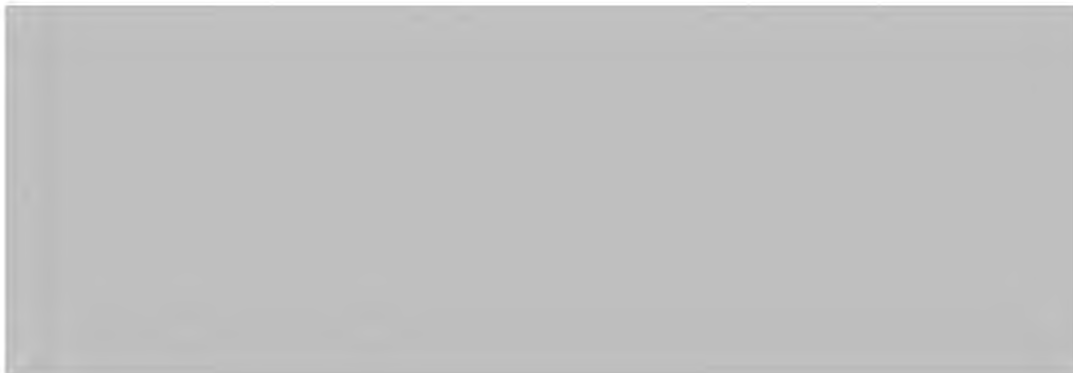
CONSIDERATIONS

To date, several groups across the country have been working to propose creating regional AI hubs or corridors, all of which are at a fairly early stage and include some collaboration between academia and industry.

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Discussions are underway between ISED, CIFAR and the three universities to try to deepen the connection between the three Canadian nodes.



NEXT STEPS

Speaking points are provided in Annex A. We are available to brief you further, at your convenience.

A handwritten signature in black ink, appearing to read 'John Knuble'.

John Knuble
Deputy Minister

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Key Points

- It is such a pleasure to meet with you today. Artificial intelligence is a fascinating sphere of research and Canada is really on the cutting-edge, leading the world in such key areas as deep learning.
- It is gratifying to see Canada's world-leading strength in AI has grown across the country, with research expertise clustered in Toronto, Montreal and Edmonton.
- I would be interested to hear more about the Toronto proposal. I am also interested in better understanding how the leading groups from across the country can work together more effectively to leverage Canada's strength globally.
- As you know, our Government values science and is committed to developing, attracting, and retaining the brightest minds here in Canada. Canada benefits from a strong base of highly qualified personnel at the centre of our innovation ecosystem, conducting the research to help solve the major scientific, economic, social, and environmental challenges of our time. I would love to hear more about what you see as the opportunities and challenges for Canada in AI with respect to talent. How do you see taking a national approach to the issue of training and talent?
- Beyond the importance of research and talent development, AI has the potential to completely change the way we work and to provide new and fascinating opportunities for industry. What is your strategy for connecting this proposal to Canadian and international industry partners?

Innovation Superclusters Initiative – Responsive

- As you know, my colleague Minister Bains is leading this initiative.
- I understand that final decisions on program design are expected in the context of Budget 2017. I expect that we will be focusing our efforts on a small set of high-impact investments with the potential to accelerate key platform technologies and drive growth across industries.
- As the government expects the field to be highly competitive, key players would need to find ways to come together and build a critical mass of talent and expertise, with industry leading the way.

CONFIDENTIAL

Minister of Science Meeting with Ed Clark regarding establishing an Ontario Artificial Intelligence Institute (OAI) in Toronto

Biography

Ed Clark, business advisor to the Premier of Ontario

William Edmund "Ed" Clark is the former Group President and CEO of TD Bank Group and current business advisor to the Premier of Ontario. Mr. Clark is part of a consortium led by the Ontario Government, the University of Toronto (UofT) and other stakeholders in the province who propose to create an Ontario Artificial Intelligence Institute (OAI).

Mr. Clark held a number of senior positions

Ed was CEO of Canada Trust. He retired in 2014 after 12 years in that role.

Mr. Clark graduated from UofT with a Bachelor of Arts degree. He went on to earn a Master's degree and PhD in economics from Harvard University. He has also received honorary degrees from Mount Allison University, Queen's University, Western University and York University.

Organization Profile

The OAI is a proposal led by the Ontario Government, the University of Toronto and other stakeholders in the province of Ontario to create an artificial intelligence institute. The purpose of the institute would be to drive the economy by leveraging and growing world class AI research in Ontario and to accelerate the commercialization of opportunities that stem from it. The proponents for the OAI primarily to fund researchers, students and postdoctoral fellows.

Artificial Intelligence Research in Canada

This overview was prepared with assistance from NSERC and Industry Sector's Emerging Technologies Directorate.

SUMMARY

Artificial Intelligence (AI) is the theory and development of computer systems that are able to perform tasks that normally require human intelligence. This includes cognitive tasks such as planning, reasoning, and learning, and also perceptual tasks such as recognizing speech, understanding text, and recognizing faces. During the past five years, machine-learning algorithms have created breakthrough performance in many traditionally challenging areas of artificial intelligence, such as image recognition and natural language understanding. Other examples of key applications include unmanned vehicles and advanced robotics.

Thanks to leading researchers at Canadian universities, and funding, Canada is an AI leader, particularly in promising subfields such as deep learning and reinforcement learning. Top poles of expertise in Canada include:

- IVADO (Montréal)
- Element AI (Montréal)
- NEXT.AI (Toronto)
- Creative Destruction Lab's Machine Learning Program (Toronto)
- Alberta Innovates Centre for Machine Learning (Edmonton)
- UBC Institute for Computing, Information, and Cognitive Systems (Vancouver)

Also, but still at the proposal stage:

- Enterprise Machine Intelligence and Learning Initiative – EMILI (Winnipeg)

Over the past few years, several leading Canadian researchers and professors have joined U.S. tech companies such as Google and to top U.S. universities. This suggests that Canada may be facing a "brain-drain" challenge.

The federal government also provides support for AI-related research through organizations such as the granting councils (e.g., Canada Research Chairs, Canada First Research Excellence Fund), CFI, CIFAR and the NRC. Details on federal funding are included in this report which also provides: Annex 1 (overview of CRCs and CERCs in AI) and Annex 2 (detailed overview of NSERC funding based on keyword searches related to AI, information is presented by year for 1991-2015 and by program for 2015-16 only).

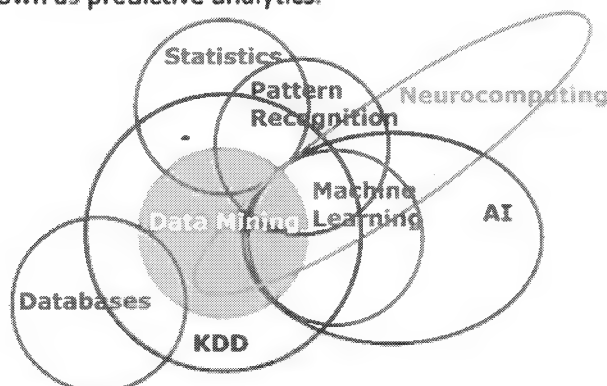
BACKGROUND

Terminology

- **Artificial intelligence (AI):** a term used to describe a machine mimicking "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving". AI research is divided into subfields that focus on: 1-specific problems; 2-specific approaches; 3-on the use of a particular tool; or 4-satisfying particular applications. The central goals of AI research include

reasoning, knowledge, planning, learning, natural language processing (communication), perception (e.g. vision, hearing).

- **Machine learning:** a subfield of computer science and AI research that explores the study and construction of algorithms that can learn from, and make predictions on, data. This goes beyond following strictly static program instructions. Within the field of **data analytics**, machine learning is a method used to devise complex models and algorithms that lend themselves to prediction; in commercial use, this is known as predictive analytics.

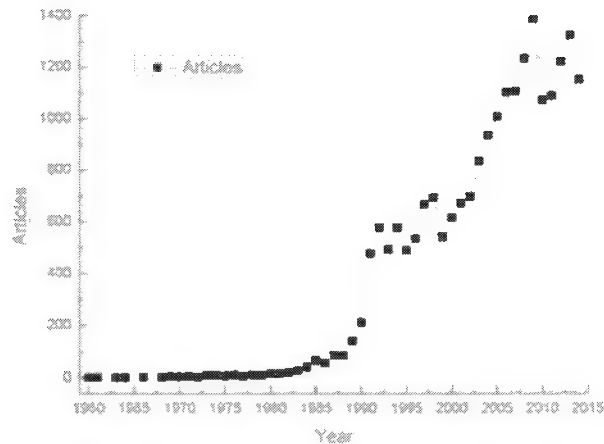


- **Neural networks:** a type of algorithm that implements machine learning by mimicking the way the human brain works. Neural networks are “trained” on samples of data and acquire an “understanding” of the data that allows them to autonomously process additional data and/or make predictions/interpolations.
- **Deep learning:** a revolutionary type of neural network and training strategy pioneered by the University of Toronto’s Dr. Geoffrey Hinton. Powerful at solving very difficult and abstract problems (e.g. image recognition and classification, voice processing), it requires an enormous amount of data to train the neural network. Until recently, this training process was prohibitively computer-intensive. This is the “hot” topic and main source of momentum in the AI field at the moment because major technical breakthroughs in high-performance computing (HPC) capacity have made it considerably easier and less expensive to use deep learning techniques in recent years and deep learning has shown extremely promising results. Google, Facebook, Microsoft, Apple, and others are investing massively in R&D in this area.

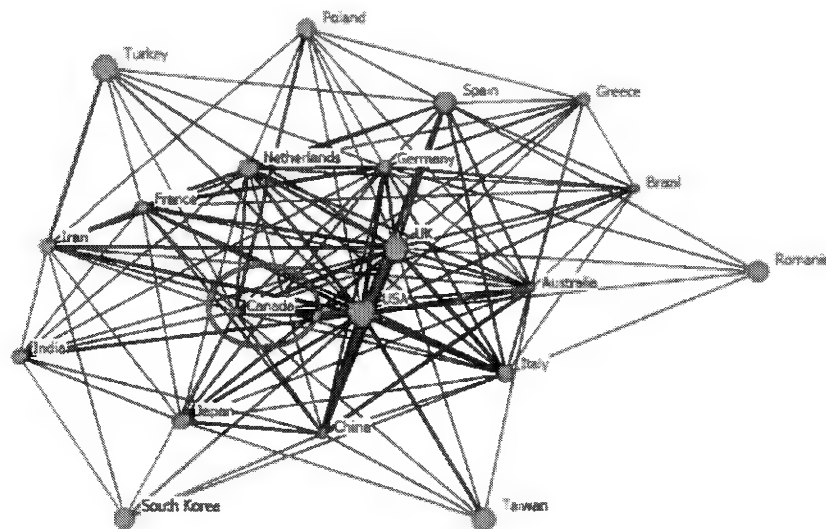
With the current momentum for developing business/industrial applications of AI, and the major focus on R&D in deep learning, the terms “artificial intelligence”, “machine learning” and “deep learning” tend to be used interchangeably.

Current Momentum

- On the academic side, recent bibliometric analysis shows significant growth in AI research since the 1990s and Canada is an important collaborator internationally.



Growth trend of articles in AI from 1990–2014.



Collaborative international networks in AI based on bibliometric data from 1990–2014.

(Both figures above were sourced from the following document provided by NSERC: Niu, J., Tang, W., Xu, F., Song, Y. 2016, May 16, « Global Research on Artificial Intelligence from 1990–2014 : Spatially-Explicit Bibliometric Analysis ». *ISPRS International Journal of Geo-Information*. 5(5), 66; doi:[10.3390/ijgi5050066](https://doi.org/10.3390/ijgi5050066))

- On the innovation side, rapid progress in AI recently made possible such breakthroughs as Apple's Siri for voice recognition, Google's text and image search functions, Facebook's facial recognition capability, NASA's rovers, and algorithmic stock trading. Currently, AI is primarily task-specific. The next step is for researchers and computer scientists to advance AI such that computers can learn general knowledge that can enable them to work in new situations, or respond better to the changing user context and mood. AI innovations are software-based, and being incorporated into personal tools (e.g., smart phones, Google glass) as new features, often at near-zero incremental cost. AI will make it possible to automate many tasks, greatly improving personal efficiency and productivity.
- By 2013, the global market for AI was valued at US\$900 million and is expected to continue to grow exponentially over the next few years. By 2025, a wave of knowledge work automation could

eliminate up to 140 million full-time jobs around the world, particularly impacting professional areas such as education, healthcare and law (i.e. legal advisors, teachers and medical practitioners).¹

CLUSTERS OF AI EXPERTISE IN CANADA

Canada is a global AI leader, particularly in promising subfields such as deep learning and reinforcement learning (an area of machine learning, similar to the ideas of game theory, focused on how software can learn to maximize the desired rewards in its decision-making).

In November 2016 at hearings of the Standing Senate Committee on Social Affairs, Science and Technology, Minister Bains and DM Knubley highlighted that AI is one the key growth sectors where Canada has the ability to attract investment and help mid-sized companies to grow and take their business global. They further highlighted that there is strong leadership in this area in Montreal and Toronto.

We have identified the following as Canada's leading and emerging centres/hubs of expertise in AI.

MONTREAL

L'Institut de valorisation de données (IVADO) – Montreal Institute for Learning Algorithms (MILA)

The IVADO aims to bring together industry professionals and academic researchers to develop cutting-edge expertise in data science, operational research and AI and create opportunities for knowledge exchange and collaborations. With over 900 affiliated scientists (researchers, post-docs, PhD candidates and research associates), the IVADO is an advanced multidisciplinary centre for knowledge in sectors including statistics, business intelligence, deep learning, applied mathematics, datamining and cybersecurity.

At the core of IVADO is the Montreal Institute for Learning Algorithms (MILA), founded by deep learning pioneer and world expert Yoshua Bengio. It is led by Bengio and six other professors from Université de Montréal. With more than 70 students, postdocs and technicians, it is one of the largest academic labs focusing fully on deep neural networks and their applications. MILA also includes associate member researchers from other universities such as McGill and the University of Toronto.

Institutions: HEC Montréal, Université de Montréal, École Polytechnique Montréal

McGill is also involved, through the involvement of some its researchers in the MILA

Partners : Hydro-Québec, CAE, Cogeco, Thales, Gaz Métro

Highlights : received a \$93M award through the CFREF

In November 2016, Alphabet (Google) announced investments of \$4.5M to support the work of seven researchers who are part of the MILA

Element AI

Launched in September 2016, Element AI is a platform to launch and incubate advanced AI-First solutions in partnership with large corporations. Composed of a research lab uniquely connected to the world's best academic ecosystems. Researchers from McGill, Polytechnique Montréal, U of Toronto, Université de Montréal and HEC Montréal.

¹ Andrew Birmingham, "140 million full time jobs created or destroyed by knowledge work automation...PART IV of our McKinsey study review", June 15, 2013, <http://which-50.com/blog/2013> [June 2014]

Highlights : In December 2016, Element AI announced that Microsoft Ventures joined the organization as a strategic investor.

TORONTO

NextAI

NextAI is a global innovation hub for AI related venture creation and technology commercialization. We identify talented teams with ambitious ideas and leverage Canada's leadership position in AI to provide them with the capital, mentorship, education and network to disrupt industries. NextAI teams have access to up to \$200,000 in capital, world-renowned faculty and scientists (University of Toronto, Georgetown University, University of Guelph, MIT, New York University, and Harvard University), a network of Canada's top business leaders and entrepreneurs, and access to cutting edge AI tools.

NextAI leverages the considerable expertise in AI at the University of Toronto, one of the most advanced AI research hubs in Canada. It focuses on five areas of study: computational linguistics and natural language processing, knowledge representation, cognitive robotics, machine learning, and computational vision. The research was pioneered by Professor Geoff Hinton's work in the area of deep learning.

Creative Destruction Lab (CDL)

The NextAI program is delivered in collaboration with the Rotman School's Creative Destruction Lab (CDL). The CDL is an incubator and accelerator based at the Rotman's School of Business (U of Toronto) that helps innovators transition from science projects to high-growth companies. It mostly invests at the seed-stage program and focuses on the transition phase from pre-seed to seed-stage funding. One area of focus for the CDL program is machine learning.

Institutions: University of Toronto

Researchers from other Canadian and US universities are also involved

Partners : a number of industrial partners and startups are involved

EDMONTON

Alberta Machine Intelligence Institute (AMII)

Amii is the Alberta Machine Intelligence Institute, a research lab at the University of Alberta that works to enhance understanding and innovation in a number of subfields of machine intelligence. It conducts leading-edge research to push the bounds of academic knowledge, and forge business collaborations both locally and internationally to create innovative, adaptive solutions to the toughest problems facing Alberta and the world. Amii specializes in the research and development of machine learning technologies, including their application in AI.

Location: Edmonton (U of Alberta)

VANCOUVER

UBC Institute for Computing, Information, and Cognitive Systems (ICICS)

A multidisciplinary research institute that promotes collaborative research in advanced technologies systems. Over 160 faculty members from across UBC (including 14 CRC holders) collaborate within ICICS and with industry. Specific research areas include biomedical technologies; robotics and control; virtual machining; signal, image and multimedia processing; wireless communications; nanotechnology; microelectromechanical systems; human - computer interaction; computational intelligence; distributed systems; integrated systems design; computer graphics; and many others.

WINNIPEG (in development)

Enterprise Machine Intelligence and Learning Initiative (EMILI)

A recent initiative based in Winnipeg and launched in March 2016. EMILI is a not-for-profit collaborative industry initiative that proposes to create a centre of excellence in Winnipeg for research, commercialization and training in machine learning technology. EMILI will work to develop commercial applications across all sectors such as manufacturing, life sciences and agriculture and also proposes to be a global voice of ethical standards related to AI.

Supporters of the proposal include Jim Carr, Liberal MP from Winnipeg and minister of natural resources, the Premier of Manitoba, the mayor of Winnipeg, and Jim Balsillie.

OTHERS:

A number of major research groups also make extensive use of AI technologies in the context of specific areas (most importantly: big data analytics) and have developed world-class expertise. These notably include:

- The Ontario Institute for Cancer Research (OICR) and the Techna Institute for the Advancement of Technology for Health (Techna), who are world leaders in computational genomics
- The Institute for Big Data Analytics at Dalhousie University
- The CERC in Data-Intensive Methods in Economics at UBC

FEDERAL GOVERNMENT FUNDING FOR AI

The federal government has supported the development of AI excellence in Canada through a number of mechanisms.

Granting agencies

NSERC: from 2005 to 2015, the Natural Sciences and Engineering Research Council (NSERC) awarded universities across Canada a total of \$171M in funding for research in the overall field of AI. In 2015-2016, through its Discovery grant program alone, NSERC invested about \$8.5M in this field. NSERC also supports a number of Canada Research Chairs (CRCs) and one Canada Excellence Research Chair (CERC) in areas related to AI (Annex 1). In 2015-16, NSERC invested \$2.8M in the CRCs.

SSHRC supports a Canada Research Chair in Computational Intelligence at UBC (Dr. Alan Mackworth).

Canada First Research Excellence (CFREF)

In July 2016, the Université de Montréal received a \$93.6M grant under the Canada First Excellence Research Fund (CFREF) program in the area of AI, Data Serving Canadians: Deep Learning and Optimization for the Knowledge Revolution, from its IVADO project lead by Dr. Yoshua Bengio. The CFREF joins Campus Montréal (the alliance of the Université de Montréal, Polytechnique Montréal and HEC Montréal) focused on a combination of machine learning/deep learning and operations research—the science of optimization. Deep learning, largely pioneered and developed on campus, provides computers with quasi-human-level performance in, e.g., computer vision and speech recognition. The CFREF, led by IVADO, aims to allow useful information to be efficiently extracted from massive data sets (machine learning) and turned into actionable decisions (operations) in area of strength for Campus Montreal, including: human health, transportation and logistics, commerce and information services, and energy networks.

Canada Foundation for Innovation

CFI has supported AI research in Canada through its funding for high-performance computing, whether through Compute Canada or as direct awards to excellent research groups. For instance through the CFI programs, Geoffrey Hinton's group received a \$240,000 contribution in 2002 and Dr. Yoshua Bengio's group (IVADO) received a \$2,000,000 contribution in 2016.

CIFAR

CIFAR has been supporting international collaboration in the area of artificial intelligences since 2004 through its "Learning in Machines & Brains" program (formerly known as Neural Computation & Adaptive Perception). The goal of the collaboration is to understand the architecture and mechanics of the brain, and how some of its processing abilities might be replicated in digital systems. The research has become the basis for the machine learning approach known as deep learning, which is used for voice recognition, image captions, translations and many other technologies. Affiliated researchers have been hired by Google, Facebook and Baidu and their collaborations continue to transform technology. The collaboration involves 29 leading scientists from across the world.

National Research Council (NRC)

The National Research Council's (NRC) Data Analytics for Engineering team targets AI applications for oil and gas, mining, defence, software and communication applications.

The NRC Industrial Research Assistance Program is supporting AI with companies that include CoreData's project for mining analytics, Invenia Technical Computing for AI modeling of energy systems, and Verafin's financial software.

Annex 1
Canada Research Chairs (CRC) and Canada Excellence Research
Chairs (CERC) in “Artificial Intelligence”

Canada Research Chairs (CRC)

<u>Name</u>	<u>Tier</u>	<u>University</u>	<u>Granting Council</u>	<u>Research Discipline</u>
Bengio, Yoshua	1	Université de Montréal	Natural Sciences and Engineering	Artificial Intelligence
Chan, Christine	1	University of Regina	Natural Sciences and Engineering	Artificial Intelligence
Gras, Robin	2	University of Windsor	Natural Sciences and Engineering	Artificial Intelligence
Guo, Yuhong	2	Carleton University	Natural Sciences and Engineering	Artificial Intelligence
Jurisica, Igor	1	University of Toronto	Health	Artificial Intelligence
Matwin, Stan	1	Dalhousie University	Natural Sciences and Engineering	Artificial Intelligence
Mostafavi, Sara	2	The University of British Columbia	Health	Artificial Intelligence
Precup, Doina	1	McGill University	Natural Sciences and Engineering	Artificial Intelligence
Schmidt, Mark	2	The University of British Columbia	Natural Sciences and Engineering	Artificial Intelligence
Tsotsos, John	1	York University	Natural Sciences and Engineering	Artificial Intelligence
Urtasun, Raquel	2	University of Toronto	Natural Sciences and Engineering	Artificial Intelligence

Canada Excellence Research Chair (CERC)

As Canada Excellence Research Chair in Data Science for Real-Time Decision-Making at Polytechnique Montréal, Dr. Andrea Lodi holds Canada’s main chair in Operations Research. The Chair’s mission is to combine knowledge acquisition through Machine Learning with decision making through Mathematical Optimization in a unified approach that is able to take advantage of the virtually unlimited quantity of data and lead to Data-Driven Innovation.

Annex 2
Overview of NSERC funding based on keyword searches

Keywords related to artificial intelligence:

- artificial intelligence
- artificial neural network
- genetic algorithm
- expert system
- fuzzy logic
- multi-agent system
- support vector machine
- machine learning
- swarm intelligence
- particle swarm optimization
- decision support system
- pattern recognition
- knowledge-based system
- case-based reasoning
- knowledge representation
- computational intelligence
- intelligence artificielle
- voice recognition

NSERC Expenditures in the Area of Artificial Intelligence

Fiscal Year	Expenditures (\$)	Fiscal Year	Expenditures (\$)
1991	\$3,126,939	2004	\$13,257,622
1992	\$2,465,795	2005	\$14,842,638
1993	\$2,128,209	2006	\$15,355,777
1994	\$2,433,478	2007	\$16,606,728
1995	\$2,010,063	2008	\$15,766,698
1996	\$2,352,649	2009	\$15,996,905
1997	\$2,471,315	2010	\$15,018,404
1998	\$3,399,268	2011	\$15,979,641
1999	\$4,283,872	2012	\$18,290,391
2000	\$5,852,350	2013	\$19,466,676
2001	\$6,763,763	2014	\$23,348,139
2002	\$8,651,415	2015	\$30,051,830
2003	\$11,582,451		
		TOTAL	\$271,503,016

NSERC Expenditures in the Area of Artificial Intelligence by Program, 2015-16

Program	Expenditures
Applied Research and Development Grants (<\$75k)	\$75,000
Innovation Enhancement Grants	\$250,000
Canada First Research Excellence Fund	\$4,739,574
Alexander Graham Bell Canada Graduate Scholarships - Doctoral	\$735,000
Alexander Graham Bell Canada Graduate Scholarship M	\$52,500
Collaborative Health Research Projects	\$55,500
Canada Research Chairs	\$2,825,000
Collaborative Research and Development Grants - Project	\$1,309,475
Collaborative Research and Training Experience	\$600,000
Discovery Development Grant	\$10,000
Engage Grants for universities	\$1,496,365
Engage Plus Grants for universities	\$12,500
Industrial Postgraduate Scholarships	\$15,000
Industrial Research Chairs	\$628,002
Industrial R&D Fellowships (IRDF)	\$30,000
Networks of Centres of Excellence - Group	\$5,343,000
Postdoctoral Fellowships - 1st and 2nd years	\$635,495
Postgraduate Scholarships - Doctoral	\$1,044,755
Parental Leave - Scholarships & Fellowships	\$22,167
Discovery Grants Program - Accelerator Supplements	\$280,000
Discovery Grants Program - Group	\$23,400
Discovery Grants Program - Individual	\$8,490,784
Research Tools and Instruments	\$238,041
Strategic Projects - Group	\$1,081,772
University Undergraduate Student Research Awards	\$40,500
Industrial Undergraduate Student Research Awards Program	\$18,000
TOTAL	\$30,051,830



Industry Canada

Industrie Canada

Assistant Deputy Minister

Sous-ministre adjoint

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JAN 27 2017

Security classification:

Confidential

CCM Number:

298102

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Action Required:

For Information

ADVICE TO THE DEPUTY MINISTER

c.c. Associate Deputy Minister

**Meeting on Creating a PanCanadian Framework for
Artificial Intelligence (AI)****SUMMARY**

- Canada is a global pioneer in the area of artificial intelligence (AI) research and development, with three main hubs of focused activity, anchored by research-intensive universities: Montreal, Toronto and Edmonton.
- To date, several groups across the country have been working to propose creating regional AI hubs or corridors, all of which are at a fairly early stage and include some collaboration between academia and industry. A Toronto-based proposal [REDACTED] to build the Ontario AI Institute [REDACTED]
- On a call this week, you, Paul Rochon and Alan Bernstein agreed to bring together representatives from the three Universities to propose they work together in rapid fashion on a consensus approach focused on talent, research collaboration and commercialization..

BACKGROUND

AI is the theory and development of computer systems that are able to perform tasks that normally require human intelligence. This includes cognitive tasks such as planning, reasoning, and learning, and also perceptual tasks such as recognizing speech, understanding text, and recognizing faces. During the past five years, machine-learning algorithms have created breakthrough performance in many traditionally challenging areas of AI, such as image recognition and natural language understanding. Other examples of key applications include unmanned vehicles and advanced robotics. AI could revolutionize medicine, industry,

Canada

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A0030090_1-000045

and transportation, and disrupt conventional industry. Through automation, AI is expected to cause major labor disruption while creating new markets and opportunities.


Thanks to talent at Canadian universities, and the foresight of funding agencies such as CIFAR, Canada is a global leader in AI, particularly in promising subfields such as deep learning (UofT and UMontréal), language processing and speech recognition (UMontréal), and reinforcement learning (UAlberta). Deep learning involves using massive amounts of data to train neural networks in decision-making through algorithms that try to find patterns through complex and high-level abstractions, much as humans do when they learn. It is used for voice recognition, image captions, translations and many other technologies. Reinforcement learning is an area of machine learning, similar to the ideas of game theory, focused on how software can learn to maximize the desired rewards in its decision-making.

CONSIDERATIONS

To date, several groups across the country have been working to propose creating regional AI hubs or corridors, all of which are at a fairly early stage and include some collaboration between academia and industry. The Ontario Government, the University of Toronto and other stakeholders in the province are proposing to create an Artificial Intelligence Institute to leverage and grow world class AI research in Ontario, and accelerating its commercialization. Ontario is seeking [REDACTED] to establish the Ontario Artificial Intelligence Institute (OAI).

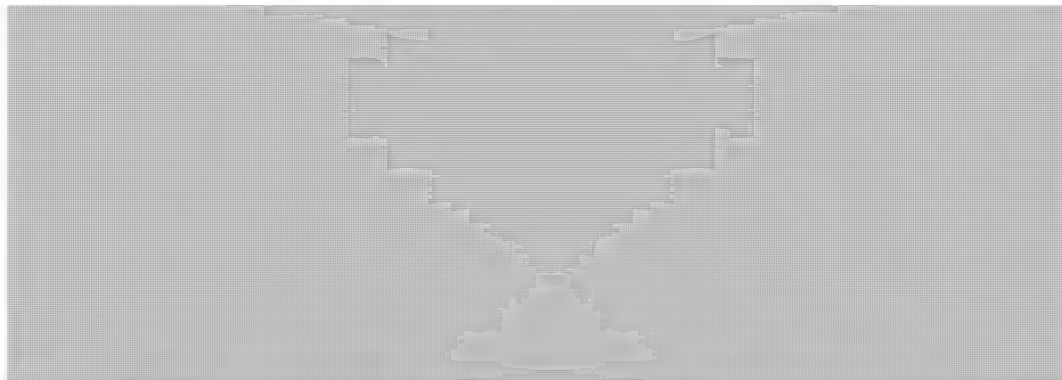
[REDACTED]
The Toronto group has developed a proposal for a pan-Canadian AI Strategy (Annex C).





Over the past few years, several leading Canadian researchers and professors have defected to U.S. tech companies such as Google and to top U.S. universities. This suggests that Canada may be facing a "brain-drain" challenge in AI. To meet the lower end of industry demand for AI PhDs, Canada would need to roughly double its current cohorts of AI students and increase its retention rate.

The current approach to AI research and commercialization, divided by region, does not allow Canada to reap the full benefits of its talent. A combined approach would increase interaction between AI scientists and corporations; help to attract and retain top talent being taken by tech giants; train more students; and better leverage provincial and federal investments to be more competitive with other jurisdictions globally.



NEXT STEPS

Key Points are at Annex A; the invitation and agenda are at Annex B; Biographies and organizational profiles – with a focus on AI – are included as Annex C. The Ontario Proposal is at Annex D and the proposal from Montreal, which was shared with participants is at Annex E.



Lawrence Hanson
Assistant Deputy Minister
Science and Innovation Sector


Attachments

CCM 298102

ANNEX B**Invitation and Agenda**

Further to the message from my office inviting you to participate in a conference call on Monday regarding a Pan-Canadian Framework on Artificial Intelligence, I wanted to provide further details about the objectives for the call, an agenda, and a background document to help focus our discussion.

The call will serve as a launching point for discussions on how to develop an integrated, strategic and truly national approach to AI, with a focus on three key areas: attracting and retaining scientific talent, specifics on managing collaboration and differentiation among the various nodes, and building linkages with the private sector so that the economic value of Canada's strengths can be realized.

 We are hopeful that the groundwork already laid by institutions in this regard means that intensive and focused discussions among them will result in a shared proposed framework.

To these ends, I would propose the following agenda for the call

11:00 - 11:10 a.m. - Opening Remarks from John Knubley and Alan Bernstein

11:10 - 11:50 a.m. - Discussion of talent, research collaboration and interaction with the private sector (All)

11:50 a.m. - noon - Discussion of Next Steps

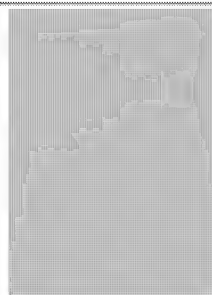
To help facilitate our discussion, I am enclosing a deck prepared by representatives of the Université de Montréal. Given limited time, I do not propose we walk through the deck at the meeting, but it will be useful if all have had a chance to review in advance.

Thank you and I look forward to the discussion Monday.

Annex C

Meeting with CIFAR, the University of Toronto, the Université de Montréal and the University of Alberta on Creating a Pan-Canadian Framework on Artificial Intelligence

Biographies:



Dr. Alan Bernstein, President and Chief Executive Officer (CEO), Canadian Institute for Advanced Research (CIFAR)

Dr. Alan Bernstein is the President and CEO of CIFAR. From 2008-2011, Dr. Bernstein was the executive director of the Global HIV Vaccine Enterprise, an international alliance of researchers and funders charged with accelerating the search for an HIV vaccine. Previously, he served as the founding president of the Canadian Institutes of Health Research (CIHR) where he led the transformation of health research in Canada. After receiving his Ph.D. from the University of Toronto, and following postdoctoral work in London, Dr. Bernstein joined the Ontario Cancer Institute and later Toronto's Samuel Lunenfeld Research Institute, where he served as Associate Director and Director of Research. Author of over 225 scientific publications, Dr. Bernstein has made extensive contributions to the study of stem cells, hematopoiesis and cancer. He chairs or is a member of advisory and review boards in Canada, the US, UK, Italy and Australia. Dr. Bernstein has received numerous awards and honorary degrees, including the 2008 Gairdner Wightman Award. He is a Senior Fellow of Massey College and is an Officer of the Order of Canada.



Dr. Meric Gertler, President and Vice-Chancellor, University of Toronto (UofT)
Vice-Chair, U15 Group of Canadian Research Universities

Dr. Meric Gertler assumed the role of the 16th President of the UofT in November of 2013. Previously, he served as Dean of the UofT's Faculty of Arts & Science, Vice-Dean of Graduate Education and Research in the Faculty of Arts & Science, and as Director of the Department of Geography's Program in Planning. Dr. Gertler holds the Goldring Chair in Canadian Studies at University College and was the founding co-director of the Munk School of Global Affairs' Program on Globalization and Regional Innovation Systems. His research focuses on the geography of innovative activity and the economies of city regions. Dr. Gertler was a member of the Expert Panel on Business Innovation established by the Council of Canadian Academies, and contributed toward its 2009 report *Innovation and Business Strategy: Why Canada Falls*

Short. He is a Fellow of the Royal Society of Canada, and received the 2007 Award for Scholarly Distinction in Geography from the Canadian Association of Geographers. He is also a Fellow of the Academy of Social Sciences (UK). Dr. Gertler received the 2014 Distinguished Alumni Award from the University of California, Berkeley and the 2014 Distinguished Scholarship Honor from the Association of American Geographers.



Dr. Vivek Goel, Vice-President, Research and Innovation, UofT

Dr. Vivek Goel was appointed Vice President, Research and Innovation of the UofT in December, 2014. Dr. Goel is a distinguished scholar with an extensive background in teaching, research and university administration. He obtained his medical degree from McGill University and completed post-graduate medical training in Community Medicine at the UofT. Dr. Goel obtained a M.Sc. in Community Health from UofT and a M.Sc. in Biostatistics from Harvard University's School of Public Health. His research has focussed on health services evaluation. He was a founding scientist at the Institute for Clinical Evaluative Sciences (ICES), where he continues as an Adjunct Senior Scientist. Dr. Goel joined the UofT in 1991 as Assistant Professor in the Department of Preventive Medicine and Biostatistics. He was chair of the Department of Health Administration in the Faculty of Medicine from 1999 until 2001, then served as

Vice-Provost, Faculty and subsequently was the university's Vice President and Provost from 2004 until 2008. He was founding President and CEO of Public Health Ontario from 2008 until 2014, where he was highly successful in building an academic public health services agency that provided scientific and technical advice to front-line practitioners. Prior to rejoining UofT he served as Chief Academic Strategist with Coursera, a global platform that connects universities and learners with online courses.

ANNEX C

Dr. Richard S. Zemel, Professor, Department of Computer Science, UofT

He attended Harvard University, where he received a B.A. in History and Science, [REDACTED] He worked at Carnegie Group for several years before moving to the Department of Computer Science at the UofT, where he obtained his Ph.D. in 1994, with U.S. Alumni and NSERC Fellowships. He completed his doctoral work, [REDACTED]

[REDACTED] where he undertook a postdoctoral fellowship in the Computational Neurobiology Laboratory at the Salk Institute. He then became a postdoctoral fellow in the Department of Psychology at Carnegie Mellon University, supported by a McDonnell-Pew Cognitive Neuroscience Postdoctoral Fellowship. Dr. Zemel [REDACTED] where he held faculty

appointments in the Department of Psychology and the Department of Computer Science at the University of Arizona before [REDACTED] to Toronto in 2000 to join the Department of Computer Science at the UofT. His research interests cover a range of topics in machine learning, visual perception, and neural coding. Specific interests include unsupervised learning, boosting, perceptual learning, representations of visual motion, multisensory integration, and probabilistic models of neural representations.

**Dr. Guy Breton, Rector, Université de Montréal (UMontréal)
Chair, U15 Group of Canadian Research Universities**

Dr. Guy Breton was appointed Chair of the U15 Group of Canada's research-intensive universities for a two-year term in August of 2016. Dr. Breton assumed his role as UMontréal's 11th Rector in 2010 and on February 24, 2014, he was granted a second mandate to begin in June 2015. [REDACTED]



[REDACTED] Dr. Breton was appointed to a senior management position with UMontréal. As Executive Vice-Rector, he was responsible for human resources, administration, finances, facilities, information technology systems, security, and pension plans. Dr. Breton was President of the Association des radiologistes du Québec from 1987 to 1997 where he represented Quebec's 500 radiologists. In 2009, the Société canadienne-française de radiologie awarded him the Albert-Jutras Prize in recognition of his outstanding career in hospitals and universities. He has been a member of the Order of Canada since 2014.

Dr. Marie-Josée Hébert, Vice-Rector, Research, Discovery, Creation and Innovation, UMontréal

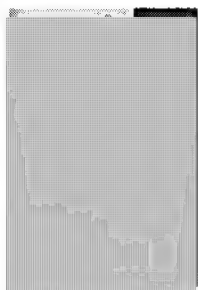
Dr. Marie-Josée Hébert earned a specialized degree in nephrology at UMontréal, followed by postdoctoral studies at Harvard. Dr. Hébert is a researcher and nephrologist-transplant physician at CHUM, professor in the faculty of medicine and holds the Shire Chair in Renal Transplantation and Regeneration. She is also co-director of the Canadian National Transplant Research Program and founder of numerous interdisciplinary and cross-sectoral research groups. Her work has enabled the discovery of new mechanisms at work in the rejection of transplanted organs. In 2015, Dr. Hébert received the Dr. John B. Dossetor Award from the Kidney Foundation of Canada in recognition of her outstanding contribution to research in kidney diseases.

**Dr. David Turpin, President and Vice-Chancellor, University of Alberta (UAlberta)
Vice-Chair, U15 Group of Canadian Research Universities**

Dr. David H. Turpin is the 13th President and Vice-Chancellor of the UAlberta, appointed in 2015. Prior to joining the University of Alberta, Dr. Turpin was President at the University of Victoria, from 2000 to 2013, Vice-President (Academic) from 1995 to 2000 at Queen's University, and was head of Botany at UBC (1991-1993). A distinguished scholar and Thomson ISI highly cited researcher in plant biochemistry and physiology, Dr. Turpin has earned many honours and distinctions for his research, teaching, and service to the community. These include the Natural Sciences and Engineering Research Council (NSERC) Steacie Fellowship, Queen's University's highest award for excellence in teaching; election to the Royal Society of Canada and membership in the Order of Canada; and the Queen Elizabeth II Diamond and Golden Jubilee

Medals. He has chaired the Canadian Research Knowledge Network and played an instrumental role in the establishment of the Major Sciences Initiatives Fund at the Canada Foundation for Innovation. Dr. Turpin continues to serve in leadership roles and is currently Chair of the Board of the World University Service of Canada.

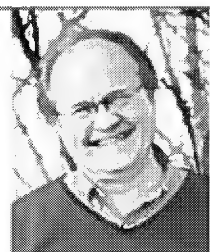
ANNEX C



Dr. Jonathan Schaeffer, Dean, Faculty of Science, UAlberta

Dr. Jonathan Schaeffer will begin his second five-year term as Dean of the Faculty of Science at UAlberta on July 1, 2017. Dr. Schaeffer received his B.Sc. from UofT, and holds both an M. Math. degree and a Ph.D. from the University of Waterloo. He has been a faculty member at UAlberta for more than 20 years, and is a former Canada Research Chair and iCore Chair in High-Performance Artificial Intelligence Systems. Dr. Schaeffer is world-renowned for his work in applying artificial intelligence and parallel computing techniques to computer game playing. He was the author of the checkers-playing program Chinook, which has been recognized by the Guinness Book of World Records as the first computer program to win a human world championship in any game. He is also the founder of Onlea, which produces online learning experiences. Dr. Schaeffer has devised several algorithms that have been used extensively, and has an impressive publication record. He was the lead investigator in putting together

the Western Canada Research Grid and related interprovincial, multi-institutional high-performance computing initiatives. Dr. Schaeffer has received many honours over the years, including being named an NSERC E.W.R. Steacie Fellow, a Fellow of the Association for the Advancement of Artificial Intelligence and a Fellow of the Royal Society of Canada. We are pleased to be able to add to his list of awards today by presenting him with our Lifetime Achievement Award from the Canadian Artificial Intelligence Association.



Dr. Randy Goebel, Professor, Computing Science, UAlberta

Dr. Randy Goebel is a Professor of Computing Science in the Department of Computing Science at UAlberta, and principal investigator in the Alberta Innovates Centre for Machine Learning (AICML). He received his B.Sc. (Computer Science), M.Sc. (Computing Science), and Ph.D. (Computer Science) from the Universities of Regina, Alberta, and British Columbia, respectively. Dr. Goebel's theoretical work on abduction, hypothetical reasoning and belief revision is internationally well known, and his recent application of practical belief revision and constraint programming to scheduling, layout, and web mining is now having industrial impact. His recent research is focused on the application of machine learning to a variety of areas, including information extraction in health and medicine, and formalization

of visualization. He has previously held faculty appointments at the University of Waterloo, Multimedia University (Malaysia), Hokkaido University (Japan) and the University of Tokyo (Japan), and is actively involved in academic and industrial collaborative research projects in Canada, Japan, China, and Germany.

Organization Profiles:

Canadian Institute for Advanced Research (CIFAR) and AI

CIFAR, a not-for-profit organization created in 1982, brings together multidisciplinary teams of researchers to explore long-term scientific, social and economic issues that are of importance to Canada. Working in association with Canadian and international institutions, CIFAR provides opportunities for eminent scholars to add to the research base in Canada. CIFAR currently supports 14 research programs with 349 fellows and advisors in a wide range of fields such as quantum information processing, experience-based brain and biological development, and institutions, organizations and growth, to name a few.

CIFAR has been supporting international collaboration in the area of artificial intelligence (AI) since 2004 through its "Learning in Machines & Brains" program (formerly known as Neural Computation & Adaptive Perception). The goal of the collaboration is to understand the architecture and mechanics of the brain, and how some of its processing abilities might be replicated in digital systems. The research has become the basis for the machine learning approach known as deep learning, which is used for voice recognition, image captions, translations and many other technologies. Affiliated researchers have been hired by Google, Facebook and Baidu and their collaborations continue to transform technology. The collaboration involves 29 leading scientists from across the world.

CIFAR's current funding expires on March 31, 2017 and the organization

This enhanced funding is intended to allow CIFAR to increase the impact of its research programs through: continued use of the Global Call for Ideas process to generate new research programs; enhanced international partnerships; knowledge outreach activities that are more targeted at key stakeholders; a revamped Global Scholars program for emerging young researchers; the introduction of new tools such as Catalyst Funds to support high risk / potentially high impact interdisciplinary research, and a new Initiatives Program to address complex global research challenges at an enhanced level and in a more expedited fashion.

University of Toronto (UofT) and AI

UofT is the leading research-intensive post-secondary institution in Canada, ranking first in *Research Infosource Inc.*'s 2016 list of Top 50 Research Universities, with nearly \$1 billion in total sponsored research funding in fiscal year 2015. This is

roughly double the size of the next largest post-secondary research enterprise in Canada. UofT is a member of the U15 group of research-intensive Canadian universities.

UofT is one of three main Canadian hubs for AI research. AI activity in the Toronto area is focused at the NextAI, a global innovation hub for AI related venture creation and technology commercialization. It seeks to Canada's leadership position in AI to provide the capital, mentorship, education and network to disrupt industries to talented teams with ambitious ideas. NextAI teams have access to up to \$200,000 in capital, world-renowned faculty and scientists (University of Toronto, Georgetown University, University of Guelph, MIT, New York University, and Harvard University), a network of Canada's top business leaders and entrepreneurs, and access to cutting edge AI tools. NextAI leverages the AI expertise at the UofT in: computational linguistics and natural language processing; knowledge representation; cognitive robotics; machine learning; and computational vision. This research was pioneered by UofT's Dr. Geoffrey Hinton and his work in deep learning. Deep learning involves using massive amounts of data to train neural networks in decision-making through algorithms that try to find patterns through complex and high-level abstractions, much as humans do when they learn. NextAI is delivered in collaboration with the Rotman School's Creative Destruction Lab (CDL). The CDL is an incubator and accelerator based at the UofT's Rotman's School of Business that helps innovators transition from science projects to high-growth companies. It mostly invests at the seed-stage program and focuses on the transition phase from pre-seed to seed-stage funding. One area of focus for the CDL program is machine learning.

Université de Montréal (UMontréal) and AI

UMontréal is a leading research-intensive post-secondary institution in Canada, ranking third in *Research Infosource Inc.*'s 2016 list of Top 50 Research Universities, with over \$530 million in total sponsored research funding in fiscal year 2015. UMontréal is a member of the U15 group of research-intensive Canadian universities.

UMontréal is one of three main Canadian hubs for AI research. AI activity in the Montreal area is focused at the Institut de valorisation de données (IVADO) Montreal Institute for Learning Algorithms (MILA). IVADO brings together industry professionals and academic researchers to develop cutting-edge expertise in data science, operational research and AI and create opportunities for knowledge exchange and collaborations. With over 900 affiliated scientists (researchers, post-docs, PhD candidates and research associates), IVADO is an advanced multidisciplinary centre for knowledge in sectors including natural language processing and speech recognition, statistics, business intelligence, deep learning, applied mathematics, datamining and cybersecurity. At the core of IVADO is MILA, founded by deep learning pioneer and world expert Dr. Yoshua Bengio. Led by Dr. Bengio and six other professors, with more than 70 students, postdocs and technicians it is one of the largest academic labs focusing fully on deep neural networks and its applications. MILA also includes associate member researchers from other universities such as McGill and the University of Toronto.

UMontréal recently received a \$93.6 million Canada First Research Excellence Fund (CFREF) grant in the area of AI, Data Serving Canadians: Deep Learning and Optimization for the Knowledge Revolution. The CFREF joins Campus Montréal (the alliance of the Université de Montréal, Polytechnique Montréal and HEC Montréal) focused on a combination of machine learning/deep learning and operations research—the science of optimization. Deep learning, largely pioneered and developed on campus, provides computers with quasi-human-level performance in, e.g., computer vision and speech recognition. The CFREF, led by IVADO, aims to allow useful information to be efficiently extracted from massive data sets (machine learning) and turned into actionable decisions (operations) in area of strength for Campus Montreal, including: human health, transportation and logistics, commerce and information services, and energy networks.

Launched in September 2016, Element AI is a platform to launch and incubate advanced AI-First solutions in partnership with large corporations. Element AI is composed of a research lab uniquely connected to the world's best academic ecosystems and includes researchers from McGill, Polytechnique Montréal, UofT, UMontréal and HEC Montréal. In December 2016, Element AI announced that Microsoft Ventures joined the organization as a strategic investor.

University of Alberta (UAlberta and AI)

UAlberta is a leading research-intensive post-secondary institution in Canada, ranking fifth in *Research Infosource Inc.*'s 2016 list of Top 50 Research Universities, with over \$470 million in total sponsored research funding in fiscal year 2015. UAlberta is a member of the U15 group of research-intensive Canadian universities.

UAlberta is one of three main Canadian hubs for AI research. AI activity in the Edmonton area is focused at the Alberta Machine Intelligence Institute (Amii). Amii works to enhance understanding and innovation in a number of subfields of machine intelligence. It conducts leading-edge research to push the bounds of academic knowledge, and forge business collaborations both locally and internationally to create innovative, adaptive solutions to the toughest problems facing Alberta and the world. Amii specializes in the research and development of machine learning technologies, including their applications in AI. It is a particular centre of expertise in reinforcement learning, an area of machine learning, similar to the ideas of game theory, focused on how software can learn to maximize the desired rewards in its decision-making.

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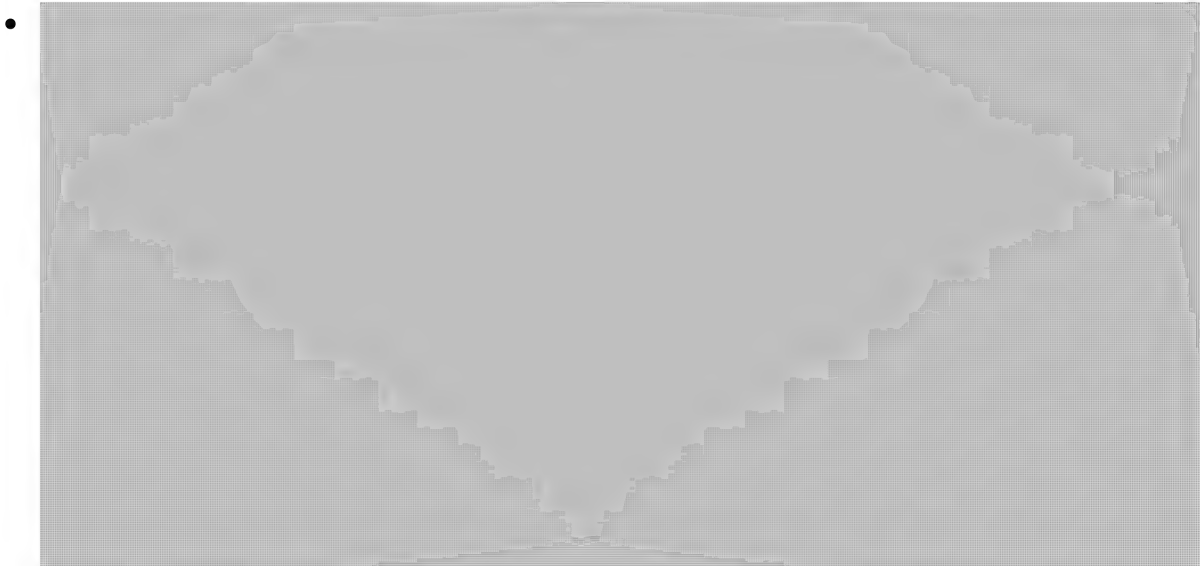
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CIFAR C-DART Proposal

Analysis of potential scenarios

Parameters of the C-DART proposal

- 
- Categories of expenditures in the C-DART proposal:
 - Canada AI Chair Program
 - Salary top-ups, teaching buyouts
 - AI Institutes
 - Equipment, personnel, core training grant, faculty who are not Canada AI Chairs
 - Salaries for researchers: grad students, postdocs, researchers on staff
 - Support engineers on staff
 - Shared equipment
 - Shared management and admin staff
 - Local training events targeted at students, postdocs & private sector participants. Include workshops, summer schools, industrial, MSc. degrees
 - Social, Philosophical and Economic Issues
 - Develop solid scholarly research and evidence
 - Workshops, public meetings
 - Admin support
 - Pan-Canadian Resources and Governance
 - admin support at CIFAR (small secretariat)
 - Training activities (e.g. conference)





- IP approach:
 - CIFAR aims to provide researchers based at the institutes with the liberty to publish and make code open-access – which it argues AI researchers want to and would therefore create an attraction/retention incentive at the Institutes
- Expected approach:
 - New and dedicated funding agreement for the C-DART initiative, separate and independent from CIFAR's Funding Agreement for its traditional suite of programs
 - This funding agreement would need to reflect the parameters set in the CIFAR Ts&Cs

Documents Reviewed & Highlights

- CIFAR Ts&Cs (2012)
- CIFAR Funding Agreement 2012-17
- ISED PAA & RPP 2016-17



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ISED PAA & RPP 2016-17

In ISED's PAA, the CIFAR program (Ts&Cs) fits under the following strategic outcome:

- **Strategic Outcome: "Advancements in Science and Technology, Knowledge, and Innovation Strengthen the Canadian Economy"**

Innovation, Science and Economic Development Canada invests in science and technology to generate knowledge and equip Canadians with the skills and training they need to compete and prosper in the global knowledge-based economy. These investments help ensure that discoveries and breakthroughs happen here in Canada and that Canadians can realize the resulting social and economic benefits.

- **Program: "Science, Technology and Innovation Capacity"**

This program sets the strategic direction for policies and programs that support and stimulate research, development and innovation in Canada. In collaboration with Industry Portfolio partners, other government departments and external stakeholders from the private and public sectors, the program fosters an environment that is conducive to innovation and promotes scientific excellence.

- **Sub-Program: "Science and Technology Partnerships"**

This program oversees implementation of science and technology programs delivered by the Department's Industry Portfolio partners. It manages federal funding agreements with arm's length organizations that support Canada's science, technology and innovation capacity. The program also conducts research and analysis in support of its oversight, governance and management responsibilities. It supports research, education and innovation in post-secondary institutions. It promotes a science and entrepreneurial culture and the development of a pool of talent in the science and technology industry. This program uses funding from the following transfer payments: Canada Foundation for Innovation, CANARIE Inc, Genome Canada, Perimeter Institute for Theoretical Physics, Mitacs Inc., Canadian Institute for Advanced Research and the Institute for Quantum Computing

In ISED's RPP 2016-17, the performance measurement parameters for the program and sub-program are:

- For the program "Science, Technology and Innovation Capacity"

Expected Results	Performance Indicators	Targets	Date to be Achieved
Canada's scientific research excellence is	Canada's Average Relative Citation index	1.31	March 31, 2017

maintained			
Researchers are attracted to Canada, and retained	Total full-time equivalent researchers in Canada per thousand total employment	8.8	March 31, 2017

- For the sub-program “science and technology partnerships”

Expected Results	Performance Indicators	Targets	Date to be Achieved
Science and technology partnerships exist between industry and academia	Dollars of cash and in-kind industrial and other contributions leveraged per dollar investment from granting councils’ science and technology industry partnership programs for which Innovation, Science and Economic Development Canada sits on governance bodies	\$2.50	March 31, 2017
	Number of companies involved in granting councils’ science and technology industry partnership programs for which Innovation, Science and Economic Development Canada sits on governance bodies	300	March 31, 2017
Federal programs are in place to support highly qualified researchers	Number of researchers including students supported by granting councils’ science and technology “people advantage” programs for which Innovation, Science and Economic Development Canada sits on governance bodies or manages a contribution agreement	3,260	March 31, 2017

Comments

- Overall, the C-DART initiative aligns well with the Strategic Outcome and with the Program and Sub-program.

- A performance measurement strategy for C-DART should focus on all four categories of expected results highlighted for the program and sub-program:
 - Scientific excellence
 - Attraction and retention of researchers
 - Partnerships between academia and industry
 - Support for highly qualified researchers

AI Institutes – Considerations regarding IP Management

Federal government's interests

- That a clear and consistent IP management framework exist across the three institutes:
 - To facilitate collaboration between the three institutes and more generally, across the country
 - To facilitate collaboration with private sector partners and government partners
 - To facilitate collaboration with international partners
 - To facilitate steps toward commercialization of research products by AI researchers who would wish to do so, including the involvement of commercialization partners (e.g. seed/angels, VC)
- That researchers at the AI Institutes be able to publish their research findings and other products in open-access:
 - To facilitate attraction and retention of talent at the institutes
- That the IP approach of the Institutes be compatible with the eventual requirements of a Supercluster initiative
- That organizations with a stake in establishing the Institutes' IP policies work together to make it possible for the Institutes to establish an IP approach as described above:
 - CIFAR
 - Research funders (federal, provincial)
 - Universities
 - Other partners, including private sector partners
- That a performance measurement strategy for the C-DART initiative not overemphasize short term commercialization outcomes.



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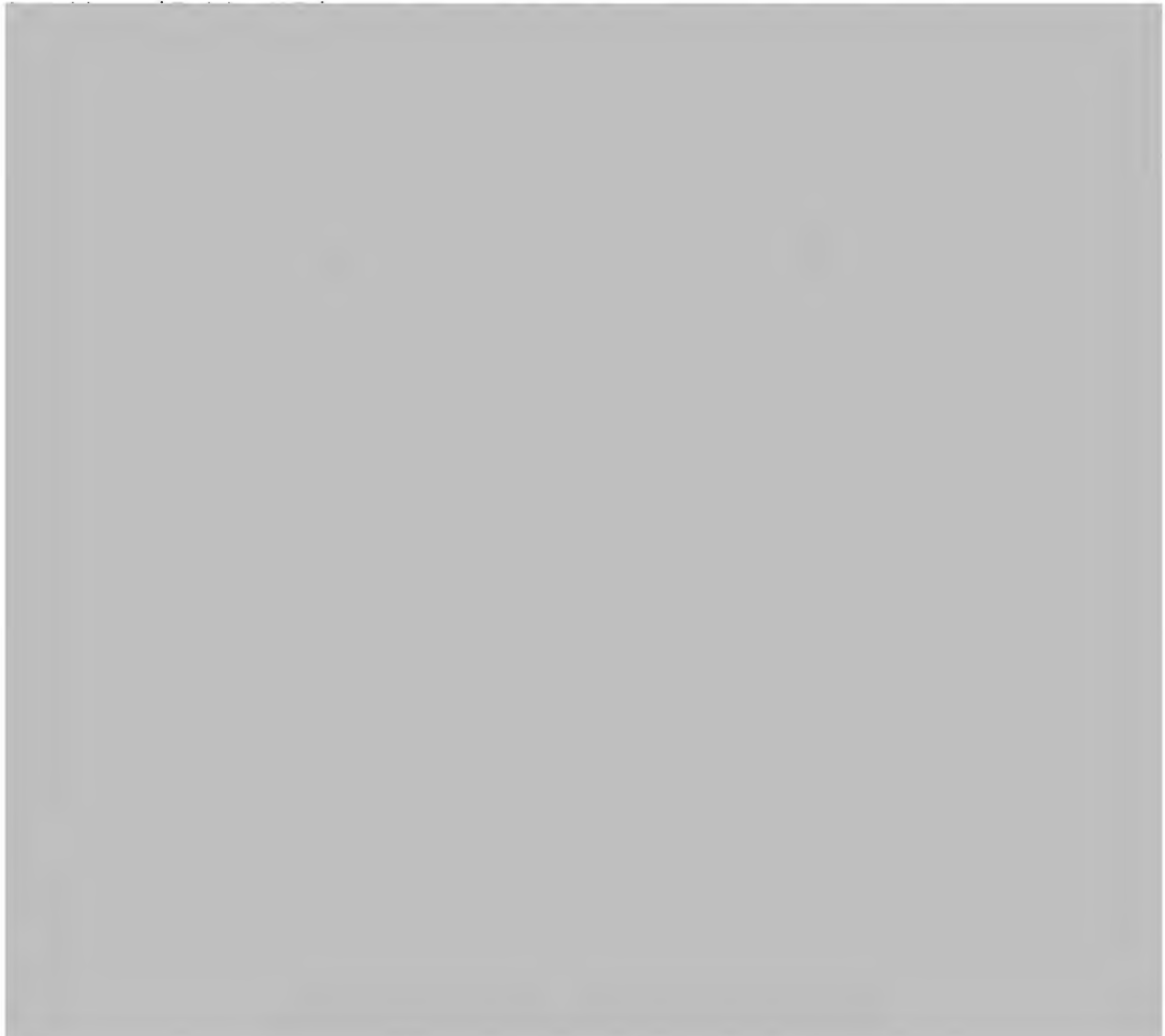
C-DART: Summary of the proposal

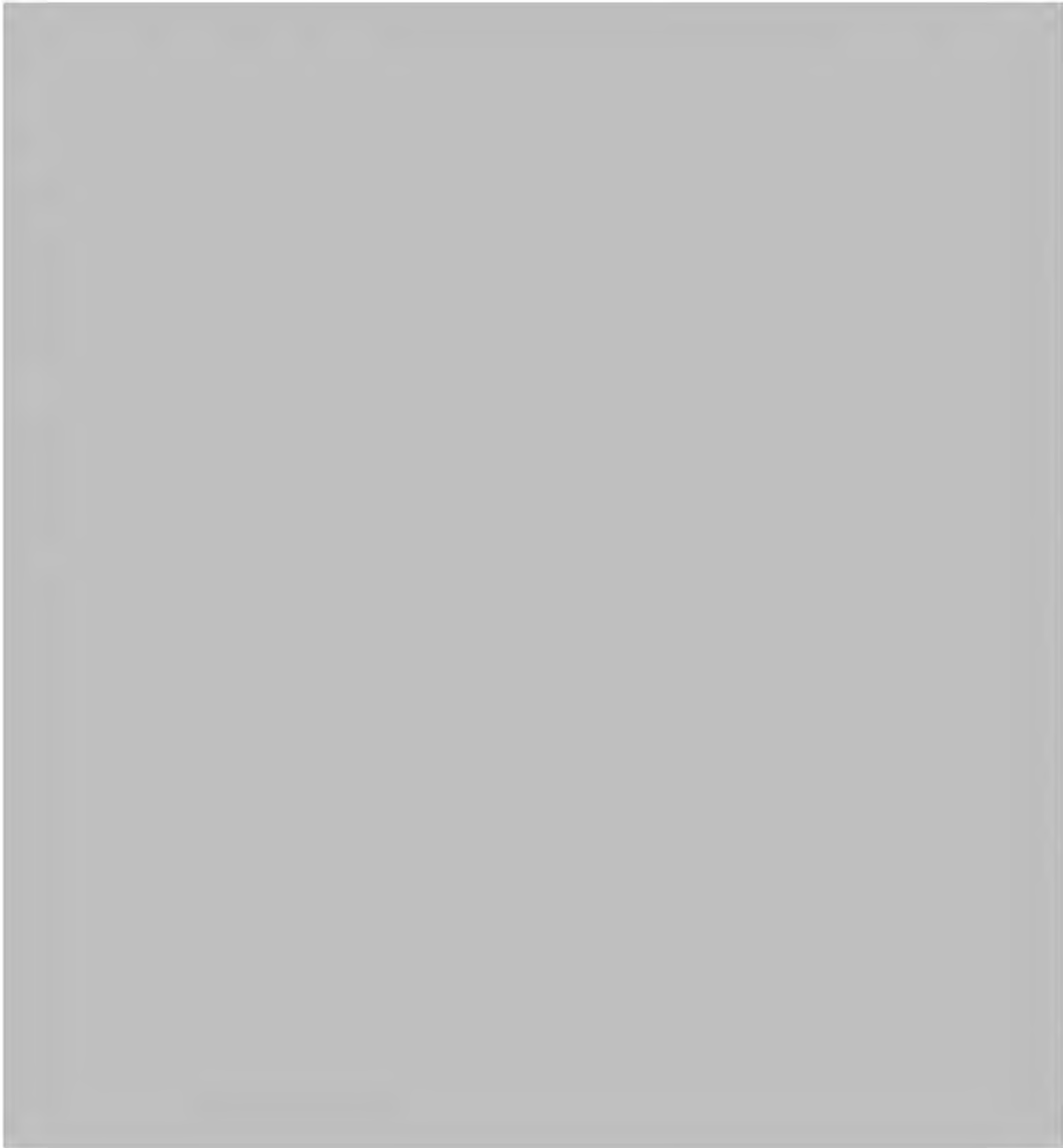
Canada AI scientific leaders are proposing [REDACTED] to accelerate AI research and talent development in Canada, especially around deep learning and reinforcement learning.

AI Talent: Recruit, Train, Retain and Connect (RTRC)

Winning the battle requires three main ingredients:

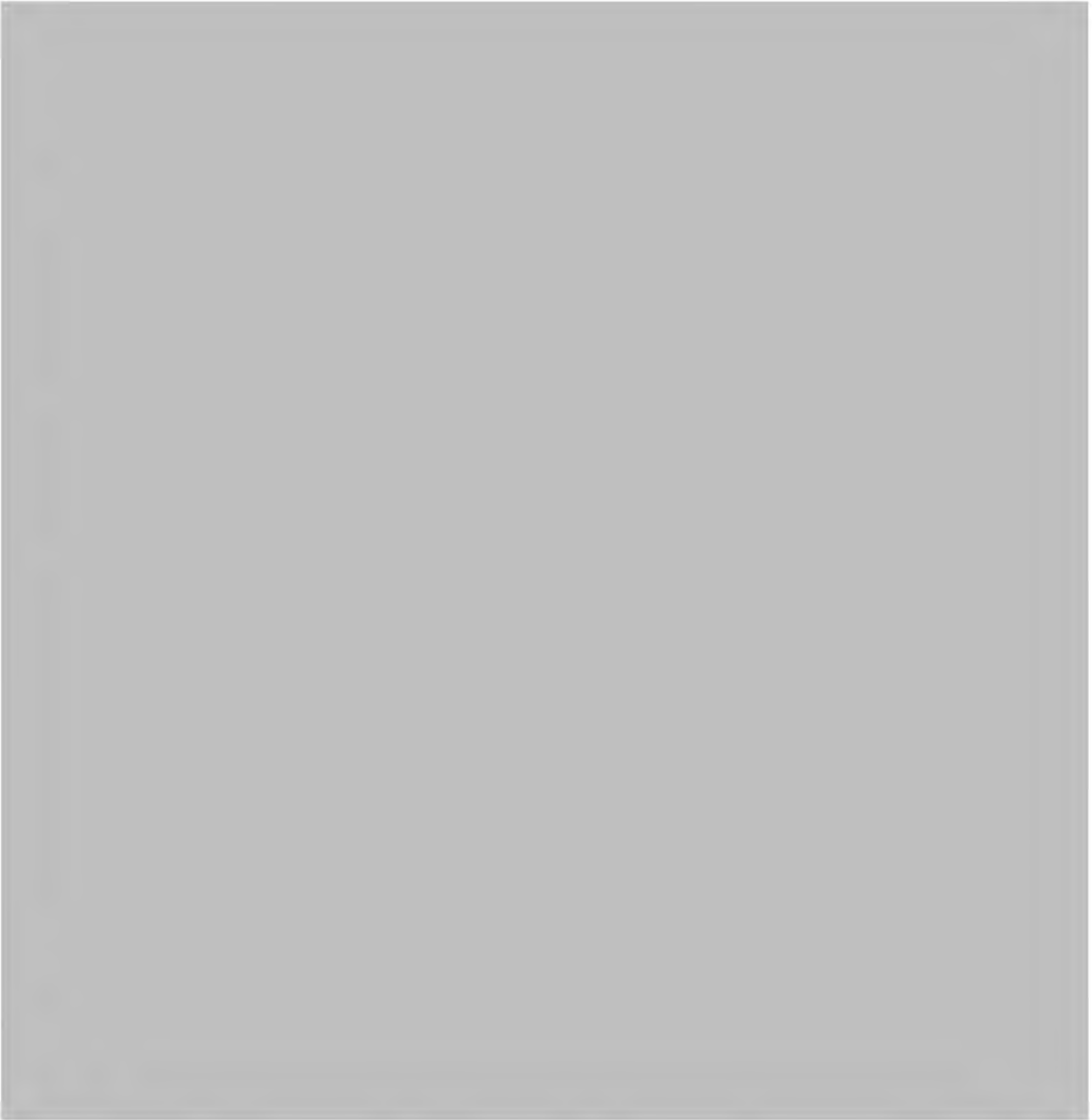
- Training a lot more highly qualified AI talent of the right kind
- Creating the condition to retain that talent
- Creating the condition to connect that talent to industry and the innovation pipeline



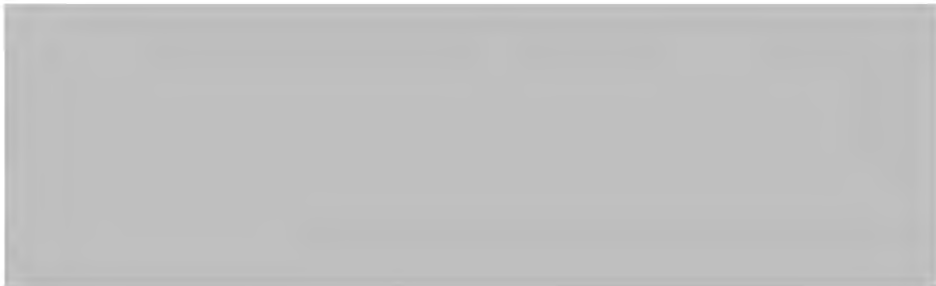


Proposed funding structure





Budget



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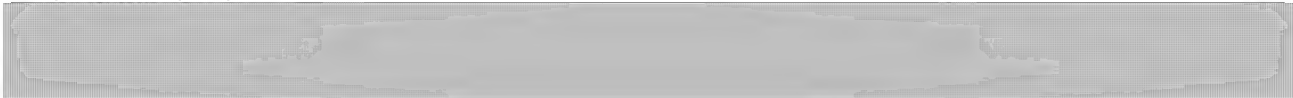
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20(1)(b), 20(1)(c), 21(1)(a), 21(1)(b)

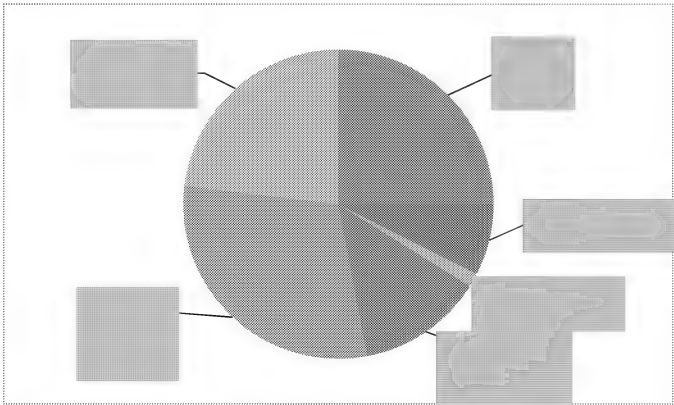
**of the Access to Information Act
de la Loi sur l'accès à l'information**

Ontario Proposal: Budget

Expenditure per year



For year 2017:



Salaries



Other research & training/skills costs





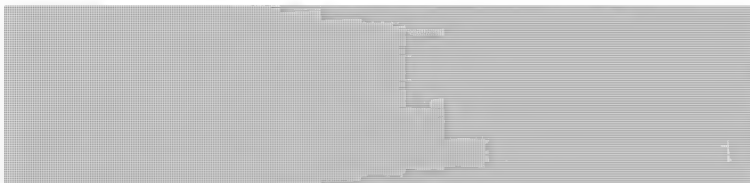
Technology adoption



Business acceleration activities



Supporting services



Admin costs



s.20(1)(b)

s.20(1)(c)

s.21(1)(b)

Toronto AI Institute Summary Budget - Preliminary (Fully Funded)



s.20(1)(b)

s.20(1)(c)

s.21(1)(b)

AI Institute Budget per Academic Year (Fully Funded)

A large grey rectangular area representing a redacted table. The table is intended to show the AI Institute Budget per Academic Year (Fully Funded) but its contents are obscured.

**Pages 149 to / à 150
are withheld pursuant to sections
sont retenues en vertu des articles**

20(1)(b), 20(1)(c), 21(1)(b)

**of the Access to Information Act
de la Loi sur l'accès à l'information**

s.20(1)(b)

s.20(1)(c)

s.21(1)(b)

Toronto AI Institute Summary Budget - Preliminary (Partly Funded)



s.20(1)(b)

s.20(1)(c)

s.21(1)(b)

AI Institute Budget per Academic Year (Partly Funded)

A large grey rectangular area representing a redacted table. The table is intended to show the AI Institute Budget per Academic Year (Partly Funded), but the content is obscured by a grey box.

**Pages 153 to / à 154
are withheld pursuant to sections
sont retenues en vertu des articles**

20(1)(b), 20(1)(c), 21(1)(b)

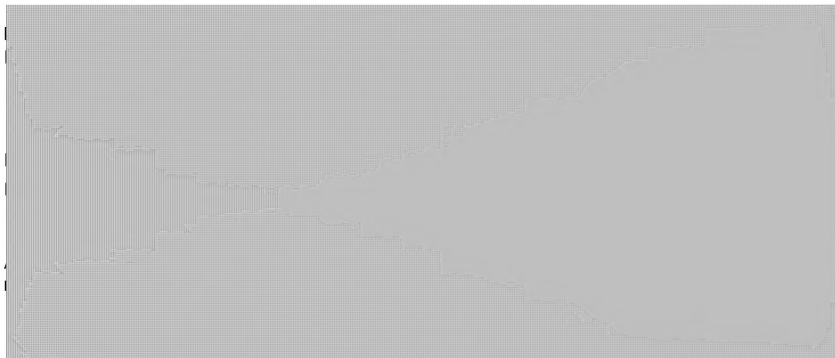
**of the Access to Information Act
de la Loi sur l'accès à l'information**

s.20(1)(b)

s.20(1)(c)

s.21(1)(b)

Student Cohort



s.20(1)(b)

s.20(1)(c)

s.21(1)(b)

AI Institute Budget per Academic Year - Analysis 1

(\$k)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10



s.20(1)(b)

s.20(1)(c)

s.21(1)(b)

AI Institute Budget per Academic Year - Analysis 2

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
(\$k)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10